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ABSTRACT

Although the development of process skills has been accepted as being an important part of elementary school curricula in science and in other subjects, few valid and reliable tests exist for their assessment. Therefore, a test is currently being developed to assess these skills. It is designed to meet seven criteria (such as testing process skills taught during the first 3 years of schooling and not being slanted toward any particular subject area). Three versions of Form 1 were administered to 318 Jamaican students in grade 3 classes in 10 rural elementary schools. The mean of this form was 20.67 with a standard deviation of 6.6. A Cronbach alpha of 0.85 was obtained. Six of the items had a facility of 0.32 or less; six of the items had a facility of 0.75 or greater. Discrimination indices were also satisfactory. Plans are underway for testing all six versions of the test simultaneously with students of the same age in Barbados, Belize, and Jamaica. It is hoped that the resulting tests will be a useful resource for assessing the levels of development of the process skills for either research purposes or for evaluating student learning due to curriculum development. (JN)

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DEVELOPMENT OF A TEST OF PROCESS SKILLS FOR GRADE 3 ELEMENTARY SCHOOL PUPILS

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For some time the development of process skills has been an accepted part of the elementary school curricula in Science and Mathematics. The same skills are frequently incorporated in other subject areas too. Unfortunately, few valid and reliable tests exist for the assessment of these skills. The few that do exist are either specific to science in that they incorporate factual knowledge, or are more suited to the upper elementary grades since they assume certain levels of reading ability that may not have been attained in the lower grades. (Ludeman 1975, Berger 1982, Burns et al 1983.)

The Show Your Skills test, currently under development, is designed to meet the following criteria:

1. It should test process skills taught in the first three years of schooling,
2. Its content should not be slanted towards any one subject on the curriculum,
3. It should be capable of being administered to a class-sized group,
4. It should assume a low level of reading ability and if possible be designed in such a way as to permit its being read aloud to the students.

Previous experiences in designing achievement tests in Mathematics and Science led to the decision that the following criteria must also be met:

5. All answers must be written on the question paper,
6. The test should not last for more than one class period (i.e. 30-40 minutes.),
7. At least three versions of the test must be prepared in order to reduce the incidence of copying.

Elementary school students in the Caribbean have very little exposure to the idea of recording their answers on mark-sence sheets or similar types of

answer sheets. A recent attempt to design a series of diagnostic tests in Mathematics planned to use computer marking. The researchers got a part of their sample to hand in all the paper on which they had done their working. They found more than 30% error in transferring the answers onto the answer sheets.(Johnson 1983). It was felt inadvisable therefore to attempt computer marking of the skills test.

Lessons in Caribbean Primary Schools usually last for 30 to 40 minutes. It was felt that if much more than this time was taken for the test, the attention of the students might start to flag.Additionally, if a test was produced that teachers could later use in their own classrooms then it was wiser to limit the time to one period.

Gross overcrowding occurs in many Caribbean Primary Schools. Seating is often bench-type, and three children frequently occupy the space designed for two. Under these conditions there is no space for separate question and answer sheets and children cannot fail to see their neighbours' answers. In fact, helping your friends is an accepted part of classroom behaviour. Administration of tests under such conditions is problematic! An attempt was made to mitigate the effects of these circumstances by developing parallel forms and variations of these.

Initially, the Show Your Skills test was designed to be used as part of the final evaluation of Grade 3 students in 5 control schools and 5 schools involved in Project Primer. This project involved a group of rural elementary schools in Jamaica and was investigating the effectiveness of the monitorial system. Tests in Mathematics, Language Arts and Social Studies were also planned as part of the evaluation. The project was undertaken by the Ministry of Education and an evaluation team was to construct achievement tests suitable for several

grade levels. The initial development of this test was therefore funded by the Ministry of Education, Jamaica.

Choice of Skills to be tested.

The evaluation team was provided with the national curricula and with a long list of general skills which students were supposed to develop by particular stages of primary schooling. Examination of the list of skills to be developed in Grades 1 to 3 showed that these could be divided into two groups: those needing a practical test and those which could be tested using paper and pencil tests. Those demanding practical examination included Collecting, Communicating Orally and Non-verbally, Observing and Classifying using senses other than sight and Recording in a wide variety of ways. The Project Director was advised of the desireability of having practical tests but felt that these could not be provided for under the schedule of testing that had been planned. These practical skills therefore remain unexamined.

The second group of skills included Classifying, Ordering, Estimating, Solving Problems etc. However, it also included skills which were felt to be at a higher level than appeared suitable for lower elementary students and these were left for a Grade 6 test which it is hoped may be developed at a later date. These skills included Making Inferences, Predicting Outcomes, Making Judgements, and Designing Experiments. Although listed as being taught in Grades 1 - 3 an examination of the curriculum failed to identify the occasions on which such skills were taught. It was also felt that, even if there was provision in the curriculum for such teaching it would be unlikely to occur since, as other writers have reported (Ost 1976; Weiss 1978; Fitch and Fisher 1979; and Anderson and Barufaldi 1980) many teachers have

great difficult in teaching using inquiry-oriented techniques.

A list of the skills that were tested appears as Table 1, accompanied by the numbers of the questions which test each skill.

TABLE 1

SKILLS BEING TESTED

SKILL		QUESTION
OBSERVATION	Something missing	1
	Spotting errors	2
	Identical objects	5 & 6
CLASSIFYING	Identifying relationships	3 & 4
	Odd - one - out	7 & 8
	Putting object into given sets	9
	Identifying additional member of a set	10
CLASS INCLUSION		11 & 12
MAGNITUDE	Greatest (money, liquid)	15 & 17
	Least (money, liquid)	16 & 18
ORDERING	Time sequencing	13 & 14
	Which comes next	20
	Height	19
	Size	25
	One - to - one correspondence	21 & 22
	Cardinality of a set	24
	Cardinality including numeral	23
CONSERVATION	Liquid	27
ESTIMATION	Length	28
HORIZONTALITY		31
SPATIAL ABILITY	Union of pieces	29
	Mapping	36
PROBLEM SOLVING	Balancing see saw	32
	Speed and distance	26
	Size	30
	Most appropriate solution	33, 34, 35
	Predicting outcomes	37 & 39
	Recognizing a fair test	38 & 40

TRIAL VERSION

Initially 3 different question were designed on each of the skills being tested. Three different trial forms of the test were produced, each having 40 questions. These trial forms were examined by 15 independent assessors from whom comments on the structure and content validity of the items was obtained. The assessors were composed of science educators, education officers and primary school supervisors in various Caribbean territories. Some of the wording and diagrams were modified as a result of their suggestions.

Three trial versions were then administered to 90 Grade 3 students in two schools in the parish of St. Andrew in Jamaica. All of the questions were read aloud so that no child should fail the test as a result of lack of reading skills. The three versions of the test were distributed so that a child had the other two versions of the test on either side of him.

Analysis of the results showed means of 24.4, 24.2 and 21.3 for the three versions. Facility and Discrimination indices were calculated for all items. All versions of two questions proved so easy that they were discarded. All versions of another question had such low levels of discrimination as to be useless. The hand-eye coordination questions which required the students to copy shapes composed of squares, circles and triangles, provided so many scoring problems that it was felt wiser to omit them. This left a pool of 108 items on 36 skills.

PREPARATION OF FINAL TEST

From this pool, two final forms of the test were assembled. Each consisted of 6 items with a facility of .2 to .3, 24 items with facilities between .35 and .7 and 6 items with facilities greater than .75 The majority of items had levels of discrimination between .3 and .8 though there were

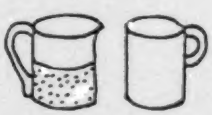
27A Mark pours the juice into the cup.

How does the cup look now?

27B Mark pours the juice into the cup.

What does the cup look like now?

27C Mark pours the juice into the cup.



What does the cup look like now?

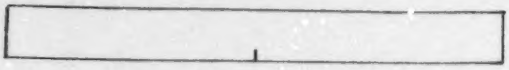
28A

This block is 10cm long.
How long do you think this line is?

It is

4cm A 5cm B 6cm C

28B



This block is 10 cm long.
How long do you think this line is?

Is it

4cm A 5cm B 6cm C

28C

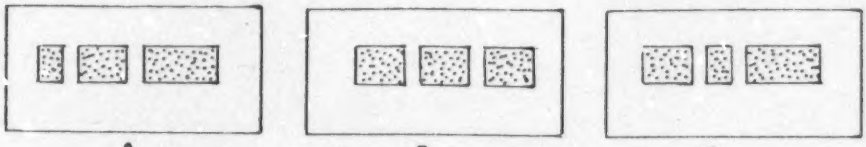
This block is 10cm long.
How long do you think this line is?

It is

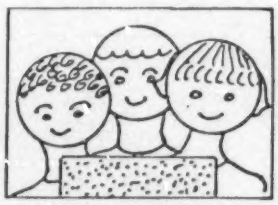
4cm A 5cm B 6cm C

34A Three friends share some candy.

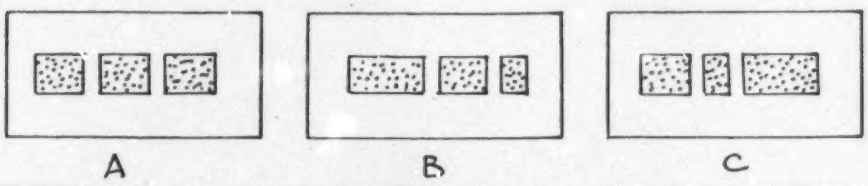
They all get the same amount.
How do they share it?



34B Three friends shared some candy.



They all got the same amount.
How did they share it?



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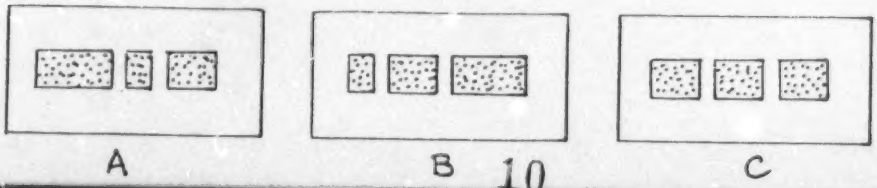
34 Three friends share some candy.

They all want the same amount.
How should they share it?



a few items whose level of discrimination went down to .2 Items were arranged so that the easier ones came first in light of Holliday's (1979) findings that suggested a sequencing effect.

Initially, 3 versions of Form 1 of the Show Your Skills test were prepared. The differences between them lay in the order of the choice of answers. Each item consisted of a very short verbal stem accompanied by a picture, and three answer pictures placed adjacent to one another. Changing the order in which the answer pictures were presented or changing the content of the stem picture allowed us to produce the 3 versions. Diagrams 1, 2 and 3 give examples of ways in which 3 versions of a question can be produced.

Form 1, versions A, B and C have been administered to 318 Grade 3 students in 10 rural schools in Jamaica. The results showed that in each version of the test there were 6 items with a facility of .32 or less and 6 items with a facility of .75 or more. We are satisfied that we achieved the distribution required.

We are not yet satisfied that we have overcome the problem of copying entirely however. We received one script which contained two answers to each question, presumably those of the individual and one of his neighbours. We also received one script of version A in which almost all of the answers were the correct answers for version B.

From comments made by the test administrators it became clear that Form 2 was important and copies were prepared. One third of the items on Form 2 are essentially the same as Form 1 items but they look different due to changes in shading, patterning, being inverted or reversed etc. In the Form 2 version of question 27 for example, the water is hatched rather than dotted.

TEST ADMINISTRATION

Both Forms 1 and 2 were recently administered to 238 students in Belize. 122 of them took Form 1 and 116 took Form 2. The sample consisted of all students

Table 2 Percentage of students of each age in each grade of the Belizian sample.

	N	Age not Known	6	7	8	8	10	11	12	13	14	15	16	Expected Age Range	Jamaican Equivalent
Standard 1	49	2	10.2	30.6	34.7	4	15.7	4						7 - 8	Grade 2
Standard 2	46			4.3	30.4	34.7	15.2	8.6	4.3	2.1				8 - 9	Grade 3
Standard 3	47	4.2			6.3	8.5	27.6	23.4	14.8	10.6	2.1	2.1		9 - 10	Grade 4
Standard 4	43					2.3	18.6	30.2	32.5	9.3	6.9			10 - 11	Grade 5
Standard 5	25						4	16	40	32	4		4	11 - 12	Grade 6
Standard 6	30						3.3	13.3	20	26.6	20	16.6		12 - 13	Grade 7
	N	3	5	17	34	23	37	38	39	26	11	6	1		

Table 3 Means on the 6 versions, by Grade: Belize sample

	FORM 1			FORM 2			OVERALL MEANS			
	Form 1.1	Form 1.2	Form 1.3	Form 2.1	Form 2.2	Form 2.3	N	Form 1	Form 2	N
St 1	19.00 (8)	21.75 (8)	21.37 (8)	15.87 (8)	16.75 (8)	17.13 (8)	24	20.70	16.58	24
St 2	18.80 (5)	21.88 (9)	24.00 (8)	22.28 (7)	22.55 (9)	20.75 (8)	22	21.95	21.87	24
St 3	30.85 (8)	25.37 (8)	27.85 (7)	23.62 (8)	24.56 (7)	24.56 (7)	23	27.82	23.86	23
St 4	28.37 (8)	27.28 (7)	25.12 (8)	28.71 (7)	25.71 (7)	26.60 (6)	23	26.91	26.85	20
St 5	28.00 (5)	21.00 (3)	29.50 (4)	21.00 (4)	27.25 (4)	27.80 (5)	12	26.75	25.53	13
St 6	29.00 (6)	26.57 (7)	28.00 (5)	31.50 (4)	30.75 (4)	25.25 (4)	18	27.77	29.16	12

Numbers in brackets indicate the number of students.

present in 2 schools in Belize City on one particular day. The schools are typical of town schools in Belize but were chosen since they are not part of a sample chosen for testing in June. The administration in Belize was a trial run to see if any of the items origionally prepared for Jamaican students would present Belizian children with problems.

On this occasion the tests were administered to all grades in the School rather than to the group for which the test was origionally designed. It was hoped that this would indicate whether the test had a ceiling beyond which it was not useful.

As is obvious from Table 2, Belize is an interesting place in which to administer tests since there is a very wide age-range in each Grade.

RESULTS

The results of the test were analysed by both Grade and Age and the means so obtained are shown in Tables 3 and 4.

Table 4 Mean scores by age: Belize sample

Age	Form 1	N	Form 2	N
6	22.66	3	14.50	2
7	20.43	7	17.00	10
8	20.68	14	19.70	18
9	23.58	12	22.36	11
10	25.85	21	24.06	16
11	26.67	21	25.88	17
12	27.15	19	25.60	20
13	24.80	10	26.20	13
14	27.91	11	(17.00)	1
15	26.00	3	29.00	3

It is immediately obvious that the numbers in many of the cells are too small to allow for any but the most tentative statements to be made about the results. It does seem that the mean scores increase with age and grade. Those students aged 13+ who are still in the primary school are likely to be the very slow ones or, since Belize has no compulsory age for initial enrollment in school, those who started school late. This may be reflected in the results.

It is unfortunate that the Jamaican sample cannot be analyzed by age, since this data was not collected by the Ministry. However the means obtained on the three versions of Form 1 from the Jamaican Grade 3 sample of 318 students are shown below:

Table 5 Mean scores, on Form 1: Jamaican Grade 3 sample.

	Form 1.1	Form 1.2	Form 1.3
Mean	22.50	20.04	19.68

Overall Mean	20.67
Standard Deviation	6.62
Cronbach Alpha	0.85

The results obtained from the Standard 2 sample in Belize more closely resemble these results than do any of the other groups tested.

An examination of the item facilities showed that the Belize sample was somewhat different from the Jamaican sample. For the Belizians, only 3 items on Form 1 and 2 items on Form 2 had facilities of .32 or less. On the other hand there were 11 items on both forms which had facilities of .75 or more.

Further examination of the facility values obtained from the Belize sample showed that if the Form 1 and Form 2 versions of an item were compared, 19 pairs of items had facilities within .1 of each other, 9 pairs of items had facilities between .11 and .2 apart, while differences in facility values of greater than .2 occurred in 8 pairs of items.

The differences in facilities of the 11 pairs of items which only differed in shading, orientation etc. are set out below:

Table 6 Facility values of paired items: Belize Standard 2 sample.

Question	Facility Values Form 1	Form 2	Facility value Difference
11	.22	.33	.11
12	.36	.42	.06
17	.45	.83	.38
18	.72	.83	.11
25	.36	.58	.22
26	.59	.54	.05
27	.45	.62	.17
28	.50	.37	.13
32	.59	.58	.01
35	.54	.66	.12
36	.40	.33	.07

It is very hard to account for these differences, and one suspects that it is an artifact ofthe sample used. It will be interesting to see if it disappears when larger samples are used.

DI3CUSSION

As will have been noted, the origional intention of producing a Grade 3 test

has been broadened considerably. Use in the two Belizian schools had indicated an increase in scores with age but has not indicated a ceiling effect. So far, no student tested has scored more than 34 on the 36 item test. Only 45 of the combined Standard 2 / Grade 3 sample of 556 students achieved a score of 30 or more.

It was felt that if the test was to be used with older elementary school students additional items might be useful. Four more items testing prediction of outcomes and control of variables have therefore been added to the end of the test. These skills are expected to be taught during Grades 4 - 6 when skills developed earlier continue to be used and practiced.

The remaining criteria stated initially remain unchanged and the test appears to meet these.

It appears at the moment as if the means on the three versions of Form 1 are a little lower for the Jamaican sample but this may be a result of the different sample sizes.

In June 1984 a further step in the test development will occur when the six versions are administered to groups of students. The sample consists of students in Barbados, Belize, St. Lucia, St. Kitts and Nevis. The schools to be used are schools involved in a large scale curriculum development project, along with their control schools. The students will be in classes that would normally be expected to contain 7 - 8 year olds, 8 - 9's, 9 - 10's and 10 - 11's. The size of the sample is such that we expect from each of the four territories about 60 scripts of each version from each of the four grades. This should give us sufficient data to be able to draw much more detailed conclusions as to the usefulness of the test.

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